January 9, 1882.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the Chair.

Number of persons present, 43.

On the recommendation of the Council, the following-named persons, previously nominated, were elected as resident members.

C. H. DENISON, CHARLES KIRCHHOFF, E. M.
SAMUEL HENSHAW, EDWARD W. MARTIN,
E. F. HYDE, W. H. RUDKIN,
VINCENT C. KING, WALTER LE CONTE STEVENS,
DR. PHILIP VALENTINI.

PROF. J. J. STEVENSON called attention to the announcement of the death of one of the oldest and most eminent fellows of the Academy, Prof. John W. Draper, and after making some remarks thereon, proposed that the society proceed to take some suitable action.

THE PRESIDENT spoke of the eminent fame of Dr. Draper, and suggested that a committee be appointed to prepare a minute expressive of the feelings of the Academy. On motion, it was voted that such a committee be designated by the chair; and Prof. Stevenson and Prof. D. S. Martin were so appointed.

Among the books received, the President called attention to the first number of the "*Bulletin of the American Museum of Natural History*," as marking an important step in the progress of science in New York city. He welcomed the appearance of this publication, which contains novel and valuable matter, with illustrations accompanying descriptions of new species; and earnestly hoped that a large and liberal and worthy policy would enable the Museum to give to the world, in this manner, the benefit of the large stores of scientific material which it has already accumulated, and which will gather more and more around such a centre.

DR. LAURENCE JOHNSON then read a paper of which the following is an abstract.

THE PARALLEL DRIFT-HILLS OF WESTERN NEW YORK.*

(Abstract.)

That section of New York State lying between Lake Ontario on the north, and Cayuga and Seneca lakes on the south, is occupied by a large number of parallel drift-hills, having a general north and south direction. Some of them are two or three miles long, and attain elevations

*This article will probably appear in full in the ANNALS of the Academy.

of 100 or 200 feet above the intervening valleys; but the greater number are shorter and lower. Many of them were, when first cleared of timber, very steep at their north ends, and on their east and west sides; but, with very rare exceptions, the southern slope is gradual.

The large valleys are generally cup-shaped, the lip of the cup being of drift material, as found by many sections observed and cited by the writer. Such valleys were originally occupied by ponds or lakelets, now obliterated by accumulations of muck or peat, though a few (Crusoe lake, Duck lake, etc.,) still remain,

The surface rocks of the region, are, beginning with the lowest, the Medina Sandstone, Clinton Group, Niagara Group, and Salina Group. The Medina occupies the surface for two or three miles south of Ontario, lying at about the level of the lake in the vicinity of Great Sodus and Port Bays; while at Oswego Falls, twenty-four miles east, and at the lower falls of the Genesee, fifty miles west, it rises 100 feet above this level—indicating a shallow valley existing, previous to the ice period, in the region occupied by the parallel hills. The Clinton and Niagara Groups together occupy a tract of four or six or more miles wide throughout the district, the latter forming the watershed between the small streams flowing north directly, or south by a circuitous route to Lake Ontario. From the Niagara Group to Cayuga and Seneca lakes, the surface rock is the Salina, which here attains its greatest breadth in the State. Above and to the south of the Salina, rise in succession the Waterlime, Oriskany, Upper Helderberg and Hamilton, in the latter of which are excavated the basins of Canandaigua, Seneca, Cayuga, Owasco, and Skaneateles lakes. The escarpment of the Upper Helderberg limestones bends several miles to the south when approaching Cayuga and Seneca lakes. This fact, taken in connection with the great depth of these lakes—more than 400 and 600 feet respectively—indicate that in this region was exerted the maximum of glacial force in western New York.

To return to the hills. These are covered to a greater or less extent with bowlders of all sizes, up to three or four feet in diameter, composed of Medina, crystalline, Hudson River, Niagara and Clinton rocks —their relative proportions being in about the order named. Their abundance diminishes from the Niagara outcrop southward. The surface soil, a sandy loam, shades downward into a non-bedded, tough clay, generally red, filled with small, sub-angular, glaciated pebbles and bowlders—in short, a typical bowlder clay, or till.

The opinion held by the state geologists, forty years ago, that these hills were formed by streams of water, is evidently erroneous, since there are no accumulations of river gravel in the valleys, such as must have remained had a broad sheet of drift suffered aqueous erosion. More-

over, the valleys are cup-shaped, even the large river valley exhibiting this feature at a number of points cited by the writer.

Nothing but glacial action is competent to explain the peculiar shape and positions of these hills and valleys; and the glacier which deposited them must have moved in a general north and south direction, bearing, however, eastwardly to the east of Cayuga Lake, and westwardly west of Seneca Lake. The long axes of all the smaller lakes in this region prolonged, converge toward a point on the present Canadian shore of Ontario. This fact would seem to indicate conclusively that the glacier radiated in cutting through, or passing over, the mountain ridge, exerting, as has been said above, its maximum of force about Cayuga and Seneca lakes. The amount of erosion indicates that the glacier occupied this region for an immensely long period; and the writer thinks he is supported by the evidence in believing it one of the first to come and last to go of all the ice-streams which swept over New York State. The evidence is, moreover, conclusive that the direction of the glacial current in this locality was not south-westerly, as generally maintained by geologists. It may have been a mere deflection of the great south-westerly current, but if so the deflection was permanent. Its great depth—about 2,000 feet from the bottom of Seneca Lake to the top of the highlands on either side, to say nothing of the mass upon their summits—must have greatly influenced its retrograde movement; and it is therefore possible that it may have blocked the entrance to the St. Lawrence and thus have held back the waters which formed some of the ancient lake regions. The last of these ridges is 200 feet above the present level of the lake, and terminates in the vicinity of Great Sodus Bay. East of this point, the valleys were too deep to admit of a continuous beach being formed; hence all the higher hills were islands, and the waters circulated freely through the valleys, depositing brick-clays in many of them. [A line of elevations was given illustrating these points.] There are, however, no fossils in these clays, showing that the water was very cold and not far distant from ice—doubtless the foot of the retreating glacier.

The writer quoted from Hitchcock (*Pop. Science Monthly*, Dec. 1881,) and Newberry (Geological Survey of Ohio, Vol. II.) in reference to the motion of the ice, etc., in the lake region; and from Geikie ("The Great Ice Age"), in explanation of the causes operating to produce the peculiar arrangement of the hills. The latter author describes such hills as occurring in broad valleys in Scotland, and believes that they are formed underneath the glaciers by alternations of lateral pressure. In the region under consideration there was a broad shallow valley, as shown by the depression in the Medina sandstone, and there must have been great and striking alternations of pressure, at least

toward the close of the period of advancement of the ice, due to the stream being forced into the deep and narrow valleys of Seneca and Cayuga—alternations of pressure which must have been felt throughout the mass for some distance northward.

DISCUSSION.

Dr. NEWBERRY expressed his opinion of the great value and importance of the observations thus given, in a region that has been much discussed and yet but little understood.

Prof. D. S. MARTIN inquired whether the direction and position of Oneida Lake would not bring it into the series of radiating lake-basins mentioned by Dr. Johnson, as the most easterly member thereof.

Dr. JOHNSON replied that while its general course would correspond with such a view, yet that the basin of Oneida Lake is so different, in its shallow character, from the others to which he had referred, that he regarded it as not related to them geologically.

Dr. J. S. NEWBERRY then read the following paper:

HYPOTHETICAL HIGH TIDES, AS AGENTS OF GEOLOGICAL CHANGE.

Prof. Robert Ball, of Dublin, has recently delivered a novel and interesting lecture, with the poetical title "A Glimpse through the Corridors of Time," in which he advances a theory in regard to the agency of the tides in producing changes on the earth's surface, which is so discordant with the facts observed and the conclusions adopted by geologists, that it would seem to call for some notice from them.

In this lecture, the views of Mr. George Darwin, in regard to the history of our telluric system, are accepted, and it is claimed that the moon was at one time a part of the earth, but that while the latter was imperfectly consolidated, it was thrown off by the preponderance of the centrifugal over the centripetal force. After the separation, according to Prof. Ball, the earth and moon revolved simultaneously around a common axis once in three hours. Since that time, the moon has been gradually receding, and lagging behind in its rotation, until it is now 240,000 miles away, and revolves but once while the earth makes twenty-seven revolutions of twenty-four hours each.

The special purpose of the lecture was the announcement of the discovery of a new agency in geological change, and one represented to be of transcendent power, viz., ancient high tides. At the present time, with the moon 240,000 miles distant, its attraction produces a tide reaching sometimes, as in the Bay of Fundy, a height of sixty feet, a tide which, in its ebb and flow, causes a considerable amount of change in the land, washing away banks and cliffs, and transporting to sea great quantities of detrital matter.

Prof. Ball asserts that at certain times in the recession of the moon

from the earth, and after the cooling of the globe had produced the precipitation and accumulation of ocean waters, the attraction of the moon acting inversely as the cube of the distance, produced tides of stupendous altitude as compared with any now witnessed. For example, supposing the earth to have been largely covered with water, when the moon was 40,000 miles away, one sixth of its present distance, its attraction must have been thirty-six times as great as at present, and its efficiency as a tide-producer two hundred and sixteen times as great as at present. This would give, for an average tide corresponding to a tide of three feet now, a height of 648 feet.

Prof. Ball pictures to his audience the effect of a tidal wave of this height rushing over and retreating from all shores twice in each short day, and justly ascribes enormous destructive power to such an agent. This condition of things he fancies to have existed forty or fifty millions of years ago, perhaps when the first sedimentary rocks now known, the old Palæozoic and Archæan strata, were deposited; and since in certain localities there were accumulations of mechanical sediments, shales, sandstones, etc., to the depth of several miles in these ages, they are explained to be the result of the action of these tremendous tides.

Prof. Ball further ascribes to this agent the greater part of the changes that have taken place on the earth's surface, and claims to have revealed to geologists in this discovery the most important factor in all their data for writing the ancient history of the globe, and one of which they seem to have been strangely ignorant.

Now, all this is exceedingly interesting, and important, *if true*; but in behalf of the geologists, I venture to report certain facts which seem to be quite irreconcilable with it. There can be no question that a tide of 600 to 1000 feet in height, sweeping over all shores and lowlands twice a day, would be a most powerful destructive and creative engine; and it may be conceded at once that its potency in remodeling the earth's surface would far surpass any agent of change now in action.

Let us imagine for a moment what the effect of a tide two hundred times greater than the present would be, if called into existence on the Atlantic coast of America to-day. The height of the tide along our coast varies from nine to twelve feet, and we may say the average is ten. This would give a height of two thousand feet to the tide produced by the moon if only 40,000 miles distant. The effect of such a flood would be so tremendous that it can hardly be realized. The whole littoral plain, two hundred miles wide, which forms the topographical margin of the continent, now half sub-marine, half sub-aerial, would be swept twice a day with a wave not less than a thousand feet in height; and a bore fifty times as high as that of the Hoogly would rush up the

Hudson and Mohawk, and sweep the valley of the Mississippi to the basin of the Great Lakes. Rocks would be torn from their beds, and with all loose material, boulders, gravel, sand and clay, would be swept to and fro with overwhelming violence, and finally be spread far out over the bottom of the adjacent ocean. All this broad littoral zone, now crowded with life, and the scene of greater vital activity than any other equal area above or below the ocean level, would become at once a howling wilderness, where nature's forces waged perpetual war, and life would be impossible.

So on all other shores, the physical and vital changes would be immeasurable. Erosion would be carried on with such energy that soon all continents would be worn away, all mountains be transported into the sea. All coral reefs, all sea-weeds, and indeed nine-tenths of all the life on the globe, would, however, be swept out of existence before that time. Half the land of the globe would be submerged and desolated, and, with the destruction of the marine and the restriction to narrow limits of terrestrial vegetation, the pabulum of animal life would be so much reduced that the globe would be practically depopulated.

It may also be said that if, as we suppose, the precipitation of ocean waters took place before the corrugations of the ear h's surface had assumed any considerable magnitude, and it was nearly or quite covered with water, tidal waves 500 feet or more in height, sweeping over the globe in rapid succession, would have worn away the emerging land as fast as it appeared, would have prevented the formation of continents and have precluded the existence of land animals or plants.

From these facts, it will be seen that if such tides had been at any time in existence on the earth's surface, traces of their action would be universal and indisputable.

Having studied with some care the geological record in places where it is as nearly complete as anywhere, I must say that I not only fail to find any proof of the existence of these stupendous tides pictured to the imagination by Prof. Ball, but, on the contrary, the whole of that record, from the Archæan to the Tertiary, offers abundant and conclusive evidence against such a theory.

As to what took place before the deposition of the Laurentian strata, we can have no knowledge, because they are the oldest known rocks yet the era of their deposition can hardly have been less than twenty or thirty millions of years ago. Though much changed from their original condition as aqueous sediments, we are yet able to recognize in them the prototypes of the sandstones, shales and limestones of later formations, and we may fairly conclude that they were deposited under like conditions. In the gneiss and granite of the Laurentian we have representatives of the coarser sediments formed along shores; the slates are the

clays of ancient times, the deposits of quiet waters off-shore; while the marbles, which in some places form a considerable portion of the Laurentian series, are undoubtedly organic sediments that accumulated in relatively deep and quiet water by the slow process of growth and decay of animal structures. Thus the slates and the limestones are records of long continuance of quiet times and the absence of great high tides. Even the gneisses and granites are strata which must have been very different from such as would be formed by the impetuous rush to and fro, over the ocean's shores, of a semi-diurnal wave hundreds of feet in height.

The Huronian series, which follows the Laurentian, consists mainly of slates, sometimes beautifully ripple-marked, and of beds of iron ore —all shore and shallow-water deposits, but speaking of quiet times and no high tides.

The Cambrian rocks are but imperfectly shown on this continent, but they are all fine mechanical sediments, or earthy limestones, often fossiliferous, deposited along the Laurentian shore, but with an absence of all coarse material and cross-bedding, such as would be produced by rapid currents or violent ebbs and flows.

In the Silurian series, which is here remarkably complete, we have a record that tells with great clearness the physical, as well as the vital, history of the continent at that age. The Potsdam sandstone is an old beach spread over large areas of pre-existent land by a slow and quiet subsidence and an invasion of the Lower Silurian sea. The Laurentian highlands, the Adirondacks, etc., formed the shores of that sea, and the Silurian rocks were deposited in it. We know with considerable accuracy the boundaries of this sea, and can trace its shore line for a thousand miles as easily as we can that of the present Atlantic coast, and can study the littoral phenomena as satisfactorily. On the old beach, as on the new, gentle zephyrs covered the shelving bottom with ripple-marks; the stems and fronds of sea-weeds are in places thickly interlaced, the beach-loving brachiopods strewed the shore with their whole or broken shells, and the boring annelids pierced the sand with innumerable holes. This automatic and indisputable record is so clear and simple that a child may read it, and it tells in unmistakable language that in the beginning of the Lower Silurian age the littoral conditions were essentially the same as now, and that no high tides such as we have been considering could possibly have swept these shores.

Above the Potsdam sandstone is spread a sheet of organic sediments —the great Trenton limestone group—in places a thousand feet thick, composed almost entirely of the hard parts of animals which inhabited the sea. These accumulated slowly age after age, in water so quiet

that the most delicate marine organisms are beautifully preserved. In places the Trenton limestones abut directly against the Laurentian cliffs which formed the shore, and which suffered so little wear that they contributed scarcely anything to the organic sediment deposited at their base. This record hardly requires translation to be understood by all, and its antagonism to the proposed theory is apparent and irreconcilable.

Toward the close of the Lower Silurian age, the sea slowly retreated from the land it had before invaded, forming wide areas of shallow water in which grew countless numbers of sea-weeds and delicate graptolites, the carbonaceous matter of which, mingling with a fine wash from the land, produced the bituminous clays which we now call the Utica slate. It is evident that the organisms which supplied the combustible matter of this deposit could only have lived in quiet lagoon-like bays, and their presence and product, with the fineness of the inorganic sediment, are incompatible with Prof. Ball's theory.

Similar phenomena teach the same lesson in the records of the Devonian, Carboniferous, and later geological ages. In the Devonian rocks we have another and apparently conclusive argument against extraordinarily high tides, for here are coral reefs, rivaling in extent those of the tropics at the present day. Now unless the reef-building polyps were formerly altogether different in habit from those now living, these coral reefs must have been formed in water not exceeding two hundred feet of average depth and not subject to great oscillations of level. High tides would now effect the rapid destruction of the whole race of reef-building animals; at the ebb exposing them to the air and sun for hours, and at the flood burying them too deeply for their continued existence.

The abundant sea-weeds buried in the rocks of the Palæozoic and later ages, offer an equally strong argument against the high-tide theory. Nearly all the sea-weeds now living in our oceans occupy the immediate shore, and chiefly grow within a depth of from 50 to 100 feet from high-water mark. It is easy to see that if the present oceans were affected by a movement like that described by Prof. Ball, the zone the sea-weeds occupy would be the scene of the greatest mechanical violence, and they would be alternately left to dry in the sun, or be torn with resistless force from their anchorage and scattered over the land washed by the flood tide. On every old beach, however, of which we find so many in the geological series, the casts of the fronds and stems of sea-weeds are as plainly discernible as on our present shores.

In view of these facts, and others of similar import which might be cited, we are compelled to reject this theory of high tides, at least for the interval which separates us from the beginning of the Laurentian

age; in other words for the entire reach of geological history; and we are compelled to infer that either the astronomers are mistaken in their views of the genesis of the moon, and that she never formed part of the earth's mass, or that her separation and recession to near her present distance took place before the beginning of geological history. Certainly so much of the geological record as is now submitted to our inspection, offers no evidence in confirmation of, but much that is diametrically opposed to, this high-tide speculation.

COLUMBIA COLLEGE, NEW YORK, *January 2nd*, 1882.

MR. WM. EARL HIDDEN exhibited a remarkable and perhaps unique stone implement from North Carolina. Its form is that of a parallelogram of nearly a foot in length, and five inches in breadth. The lower face is slightly convex from end to end, and its upper face rises into a conical or pestle-shaped handle, some six inches high, at about the center. Dr. Newberry had suggested that its probable use was as a corn-muller. The specimen was plowed up in a field near Waynesville, Haywood Co., N. C., some three years ago, and has been in Mr. Hidden's cabinet for over a year. The material is a very compact gneiss.

THE PRESIDENT remarked further on this very singular implement, and repeated his belief that it was probably used to grind corn, upon a flat or concave stone, making comparison of it with other forms of mullers, etc., known to us from various parts of America.

He also laid before the Academy some of the advance plates of the Palæontology of New York, prepared for the forthcoming volume by Professor Hall, and spoke of the great importance of a proper appropriation by the Legislature for the completion of this noble monument to American science. There was danger that much of this carefully prepared material might fail of publication, and be lost to science, by a mistaken and unworthy policy of "economy," and he suggested that the Academy might, with great propriety, memorialize the Legislature on this subject.

Other remarks were made, in the same spirit; and it was voted that the President and Secretary be constituted a committee to express the views of the Academy in the direction indicated.

January 16th, 1882.

SECTION OF PHYSICS AND ASTRONOMY.

The President, Dr. NEWBERRY, in the Chair.

Twenty-seven persons present.

Prof. JOHN K. REES read the following paper:

THE INTERNATIONAL TIME-SYSTEM.

For the past thirty years, observatories situated in different parts of the world have undertaken to "give time" to their adjoining sections of country, by the use of the electric telegraph.[1]

At this present moment, prominent places in England and Scotland receive their time-signals from the Royal Observatory at Greenwich. There is but one standard time for the island, viz., the Greenwich time —Ireland probably gets her time from the Observatory at Dublin.

In Paris the Observatory clock controls by electricity many secondary clocks of fine workmanship distributed throughout the city.

There is also in Paris another system for distributing time, viz., the Pneumatic system. Dials in private houses, on the streets, etc., are connected by pipes with a central reservoir containing air. From this reservoir, by proper mechanism, is sent every minute an impulse, which, compressing the air in the pipes, moves the minute-hand of each dial forward one minute-space. The system has met with great popular success on account of its cheapness. It is to be said, however, that the time required for the impulse to travel from the reservoir to any dial is appreciable, and varies with the distance of the dial from the central reservoir. Some of the dials are therefore ten to twenty seconds slower than dials near the impulse-generator.[2] From many other observatories in Europe radiate time-systems of greater or less extent.

In our own country, the observatories at Washington, Cincinnati, Cambridge, Albany and New York, began about twenty-five years ago to furnish time to railroads, jewelers and government offices. The demand for accurate time has increased each year, until now we find many widely extended systems. The most important of these time-distributing centres are as follows:

1. The Naval Observatory System of Washington, D. C. This system drops a noon-time ball in Washington, furnishes time to the government and city offices, and to the railroads. The Observatory clock can be connected with the wires of the Western Union Company, so that time-signals can be sent to any part of the United States.[3]

2. The Harvard Observatory System, Cambridge, Mass. This supplies time to many business houses in Boston, drops a noon-time ball from the roof of the Equitable Life Insurance Company's building, and furnishes all the railroads entering Boston, and other roads, with clock signals.[4]

3. From Allegheny, Pa., Professor Langley sends time to Pittsburg, and also to the Pennsylvania Railroad.[5]

4. The Dudley Observatory at Albany furnishes time to Albany, and to the New York Central Railroad.[6]

5. The Observatory at Mount Lookout, near Cincinnati, supplies the city with time-signals, and several railroads get their time from the same observatory.[7]

6. The New York City system is under the control of the Western Union Telegraph Company. A noon-time ball is dropped from a pole on the roof of the company's building, and clock signals are sent to many subscribers in the city. The central clock here is regulated by time-signals received from the Naval Observatory at Washington, from Professor Langley's observatory at Allegheny, Pa., and from Harvard Observatory.

7. The Winchester Observatory (Yale College) system distributes time to the railroads and to several cities in the State of Connecticut. The State "has enacted a statute making the use of New York time compulsory upon all transportation companies within her limits."[8]

8. The Dearborn Observatory, of Chicago, is the centre of that city's time-system, and supplies several railroads with time-signals.

9. Radiating from the Observatory of Washington University, St. Louis, there is a city time-service of considerable extent.[9] Arrangements have been made to send time-signals over the railroad lines centering at St. Louis, South as far as Texas, and West probably as far as Denver.

10. The Morrison Observatory, at Glasgow, Missouri, using Western Union wires, now drops noon-time balls, at St. Louis and at Kansas City, and sends time-signals along several railroads.

These are the most prominent time-centres in the United States. But there are many other centres of less importance. From almost every public and private observatory time is sent, in one way or another, for the regulation of neighboring clocks.

Every year the demand for accurate time becomes stronger and more extended. The supply is fully equal to the demand It is possible for any business concern or private individual to obtain accurate time from some observatory near by at very small expense and trouble.

The instant of mean or clock noon, at any place, is the time when the mean sun is on the meridian of the place. It is noon then for all places on that meridian. In four and a half seconds (for lat. 40°40) it is noon for places on the meridian about one mile west of the first meridian. Places about fourteen miles west of the first meridian will have local noon one minute later, and so on.

No two places can have, astronomically speaking, the same local times unless they are on the same meridian.

In large cities, and over lines of railroads, it has long been the custom to disregard the changes in the local times as we pass to the east and to the west; and the time, say, of the City Hall is used as the standard

time for the whole city; and the time of some city on its line is employed as the standard time for railroads. The time adopted by a railroad soon becomes the standard for all cities along its line, and, shortly, local time, in its astronomical or true sense, is disregarded.

Prof. Cleveland Abbe has shown, in his report to the Metrological Society, that there are now used in this country, in operating railroads, seventy-five different standards of time. "Some of these are in error about a minute or more. Many do not differ among themselves more than one or two minutes. Some of them are furnished with uniform high accuracy by established observatories, others are furnished by jewelers employed by the railroads, and many are of very doubtful reliability."[10]

The scientific men of the country have long felt that there are too many standards, and that there is no system used in adopting them.

The subject of the "Simplification of Time Standards" was taken up in 1875 by a Committee of the American Metrological Society.

This Committee, adopting a system of Prof. Benj. Pierce, recommended (in 1879): *First.*—That the number of standards of time be diminished, and *second*, that there be no more than one standard for every hour of longitude west of the meridian of Greenwich.

The relations of the proposed standard meridians, to Greenwich (in longitude and time), to true local times of places adopting the standards, and the designation of the proposed standard times, are given in the following table:

Geographical Section.	Standard Meridian west of Greenwich	Standard Time slower than Greenwich	Standard Time slower or faster than true "local times."	Designation of proposed Standard Time.
		H. M. S.	Min.	
Newfoundland,	60°	4. 0. 0.	20 slower than St. Johns, N.F.	East'rn Time
New Brunswick,			24 faster than St. John, N. B.	
Nova Scotia,			14 faster than Halifax, N. S.	
Canada,			15 slower than Quebec.	
			18 faster than Toronto.	
Maine to Florida,	75°	5. 0. 0.	16 slower than Boston.	AtlanticTime
			3 slower than New York.	
			8 faster than Washington.	
Ohio to Alabama			19 faster than Charleston.	
			45 faster than Montgomery.	
Lower Lakes,			14 faster than Buffalo.	
			30 faster than Detroit.	
			38 faster than Cincinnati.	
			0 faster than New Orleans.	
Miss. Valley,	90°	6. 0. 0.	1 faster than St. Louis.	Valley Time.
Missouri Valley,			12 faster than St. Paul.	
Upper Lakes,			18 faster than Kansas City.	
Texas,			19 faster than Galveston.	
			10 slower than Chicago.	
Rocky Mt. Region.	105°	7. 0. 0.	0 faster than Denver.	Mount'n time
			28 faster than Salt Lake City.	
			12 slower than San Diego.	
Pacific States,	120°	8. 0. 0	10 faster than San Francisco.	Pacific Time
British Columbia,			11 faster than Olympia.	
			12 faster than Victoria.	

The section of country situated 7½ degrees on either side of a standard meridian would adopt the time of that meridian. The greatest difference necessary between the *true* local time of a place and the standard meridian would be thirty minutes. These sections of country in this latitude would be about 790 miles wide; at the equator about 1,040 miles wide. As we pass from section to section the time would change by whole hours, the the minute and second remaining the same over the whole country.

As a step in advance, it has been proposed that the railroad and telegraph companies adopt the 90° or 6-hour meridian from Greenwich, (running down the Mississippi Valley and passing through New Orleans) as their standard meridian for the whole country. This time it was proposed to call "Railroad and Telegraph Time."

n the same way it has been proposed to use the meridian through Washington. The meridian through New Orleans being more nearly a central bisecting line for the United States, and being exactly 6 hours from Greenwich, would appear to be the one best suited to the object in view.

Some parties have gone so far as to urge the adoption of one line meridian by the people generally. I can see no objection to the railroad and telegraph companies using the 6-hour meridian, provided the relation of the "R. & T." time to the adopted local time at any place is thoroughly understood. It is, however, too early to urge the acceptance of one meridian on the whole people. If we should adopt the 6-hour meridian as the standard for all local times, business and social engagements would begin at widely different times in different sections of the country. Banks would open in New York City, Boston, etc., at 9 o'clock, theatres would begin their performance at 7 P. M. In St. Louis, Chicago, etc., these same openings would occur at 10 A. M. and 8 P. M. In San Francisco the time would be 12 o'clock for bank, and 10 o'clock for theatre openings; and in like manner for other business and social engagements.

But all the systems so far spoken of are but steps toward the adoption of a uniform standard for the whole earth.

This international system was proposed independently by Hon. Sandford Fleming, Chancellor of Queen's University at Toronto, and by Prof. Cleveland Abbe of the U. S. Signal Service.

The proposed system is plainly outlined in the following

PREAMBLE AND RESOLUTION submitted to the Association for the Reform and Codification of the Law of Nations, at their meeting in August, 1881, at Cologne, in Rhine-Prussia, by President F. A. P. Barnard of Columbia College.

Whereas, Since the creation of a vast system of artificial lines of rapid transit and telegraphic communication, extending through wide differences of longitude upon both continents, great confusion in time reckoning has arisen in consequence of the use, throughout the same districts of country, of the differing times of many local meridians; and,

Whereas, The actual time in use at any place is generally arbitrary and at variance, often by many minutes, with the true local time of such place; and,

Whereas, Such differences between true and arbitrary time are in no way practically disadvantageous in the affairs of life, when universally understood and observed; and,

Whereas, It is practicable, by referring the times of all places on the globe to a limited number of meridians suitably chosen, to create a time-system for the world, so nearly uniform that the minute and the second shall everywhere the same, and the times of places widely differing in longitude shall differ only by entire hours—a system of great simplicity and likely to be conducive to the convenience of all mankind; therefore,

Resolved, That this Association approves and recommends to the favorable consideration of the governments of all nations, as well as to all scientific associations, chambers of commerce, boards of trade, and telegraphic and transportation companies, a time-system for the world, founded on the following principles:

1. Twenty-four standard meridians to be fixed upon, distant from each other fifteen degrees, or one hour each, in longitude, to which, and to which only, the arbitrary local times kept at all places on the earth's surface shall be referred.

2. The prime meridian, or that by reference to which the positions of all the remaining one-hour meridians are to be determined, to be the meridian situated in longitude one hundred and eighty degrees, or twelve hours, distant from the meridian of Greenwich, which prime meridian passes near Behring's Strait and lies almost wholly on the ocean.

3. The diurnal change of count in the monthly calendar to begin when it is midnight on this prime meridian, and the same change to take place for the several meridians successively, until the circuit of the globe has been completed from east to west.

4. The hour of the day at any place to be regulated by the standard meridian nearest such place in longitude, it being reckoned as twelve o'clock, noon, at the moment the mean sun passes such standard meridian. The minute and second to be the same at all times and for all places throughout the earth.

5. The hours of the day to be numbered from one to twenty-four without interruption, and the division of the day into two halves of twelve hours each to be abandoned.

6. For special purposes, as with a view to promote exactness in chronology and to facilitate synchronous observations in science, the day and the time of the day as determined by the prime meridian to be employed as a kind of universal time-reckoning, under the name of COSMOPOLITAN TIME.

7. For the sake of distinction, the hours of Cosmopolitan Time to be denoted by symbols and not by numbers; and preferably by the letters of the English alphabet taken in their order, which, omitting J and V, are twenty-four in number—these letters being also associated with the standard meridians in regular order from east to west, so that F corresponds to the 90° meridian passing near Calcutta, M to the Greenwich meridian of 180°, S to the meridian of New Orleans, 270°, and Z to the prime or zero meridian.

In proposing these resolutions, President Barnard made the following remarks:

* * * * * *

"The bounding lines between the successive meridians at which the count of the hour shall change, it is not proposed to define with the same geometrical precision which characterizes the meridians themselves. The idea is rather to follow any well-known natural or political divisions which fall approximately midway between the meridians, and which will serve as easily remembered reference boundaries. On the American Continent, such lines of demarcation are easily found. The States and provinces which touch the Mississippi river will use valley time; the Canadas, and the States of the Union which lie east of these valley States, and most of which touch the Atlantic, will use Atlantic time; the British provinces farther eastward will use eastern time; the States and provinces which touch the Pacific, will use Pacific time; and all those which lie between the Pacific States and the valley States will use mountain time.

The means by which we expect to establish this system on the American Continent, are partly the voluntary action of the transportation companies; partly the co-operation of municipal corporations and chambers of commerce; and partly local legislation. Already many local organizations have taken steps for the establishment of time-balls and other time-signals in furtherance of the practical introduction of the system. The State of Connecticut has enacted a statute making the use of New York time compulsory upon all transportation companies within her limits. * * * * *

The Governor-General of Canada, the Marquis of Lorne, has been

pleased to interest himself actively in promoting the success of the movement. The papers relating to it which have been published by the two associations whose titles have just been mentioned[19], have been forwarded by Lord Lorne, through the British Foreign Office in London, to countries with which Great Britain is in diplomatic relations, and to their scientific associations; and from the Imperial Academy of Sciences at St. Petersburg have been received copies of a report from a committee, of which the eminent astronomer Otto Struve was chairman, cordially approving the project; which report was adopted by the Academy.

Two or three minor features of the scheme contained in the resolutions proposed remain to be mentioned. The first of these is the proposition to abolish the present division of the day into two equal portions of twelve hours each, and to employ instead a continuous count running from one to twenty-four hours in each day. The division at present in use is not a natural one. It is founded, presumably, upon the custom of astronomers to begin the day at the meridian passage of the sun, or the habit of the people to fix the moment of apparent noon by observing the coincidence of the shadow of a vertical style with a line drawn north and south. The natural division of the day is into a light portion and a dark portion. These portions are always and everywhere unequal, except for a single day in the year, or for a single great circle of the earth—the equator. No exact system for the uniform division of time can therefore be founded upon them. On the other hand, no disadvantage can arise from regarding the day as a unit, subdivided into twenty-four equal fractions, a mode of division once very general, at least in Italy, and hardly yet entirely abandoned; while there are very appreciable disadvantages attending the present division into twelve-hour moieties. The first of these is the necessity of using always in speech the word *forenoon* or *afternoon*, in order to identify the portion of the day to which any hour which happens to be mentioned or is to be referred; or, in writing, to place after the number of the hour the explanatory suffix A. M. or P. M. Another and even greater is the uncertainty in railway time-tables as to whether a particular hour is an hour of the night or of the day. The compact form of these tables renders it impossible always to introduce the necessary specifications in their columns, and the inquirer is thus often left at a loss. Some of the tables, in order to remove the embarrassment, have employed the expedient of printing the hours of the night in white letters upon a black ground, while those of the day are printed in the usual way with black letters upon a white ground[18]; but the very adoption of this expedient is a confession of the existence of an evil which we may easily perceive to be quite unnecessary. Let the hours

of the day be only continuously numbered from beginning to end, and there will never be any uncertainty as to which part of the day is meant.

Another of the secondary features of the scheme is the designation of a zero meridian. The zero meridian is that from which terrestrial longitudes begin to be reckoned, and that at which, at the close of the day, the count of the day in the monthly calendar shall be momentarily the same for the entire globe. Any meridian which might be chosen, and which should be generally accepted, would answer for this purpose; but such a selection ought not to be made through mere idle caprice. Regard should be had to usages actually existing; and if there is any meridian which has already become more familiar than any other to the great majority of mankind, that circumstance should be counted in its favor. In a contribution made by me some ten years ago to a provisional code of international law drawn up under authority of a resolution of this Association, by the Hon. David Dudley Field, afterwards President of the Association, I endeavored to assign some reasons why the meridian of Greenwich is entitled to be regarded as rightfully the first meridian for purposes of longitude. But the same reasons apply with equal force to the inferior meridian of Greenwich--that is to say, to the meridian twelve hours distant in time, and 180 degrees distant in longitude from Greenwich itself; and as I have found, in consultation wirh others, that there might be danger of awakening national susceptibilites by insisting on Greenwich (though, for myself, I fail to find this consideration serious), I have yielded my first opinion, and propose to fix the first meridian for time and for terrestial longitude at the 180th degree from Greenwich, so that this first meridian will fall almost entirely upon the ocean. As in the monthly calendar the change of count must begin at some particular meridian, it is desirable that this change shall take place, if possible, beyond the limits of all habitable lands; and this is true of the meridian proposed, since, except a small portion of wild and desolate sub-arctic Kamschatka, it scarcely touches any portion of the earth's surface uncovered by water. At this assumed first meridian, therefore, the day in ordinary chronology will begin when the mean sun is on the meridian of Greenwich; so that in fact it will be identical with the astronomical day as reckoned at that observatory.

The last of the secondary features of the scheme which I have to notice, is the proposition to establish, for purposes of pure chronology, and for the facilitation of synchronous observations in science, a special time-reckoning under the name of *cosmopolitan time*. So long as the dimensions of the known world were limited in longitude between the Indies on the east and the Canary Islands on the west, there was no

danger of a confusion of chronology to arise from a mistake of an entire day in a date. But at the present time, and since civilization has encircled the entire globe, it is a fact that there are certain hours in every twenty-four, during which, for one entire half of the habitable world the date is a unit more advanced in the monthly calendar than in the other. The change of count must have a beginning somewhere. In the absence of any distinct convention on the subject, it is generally understood that this change begins somewhere in the Pacific Ocean. It happens, therefore, that at the moment when the sun is on the meridian opposed to that of Greenwich, the date for all Asia and all Continental Europe may be, for example, the first of January before noon, while for the entire American Continent it is still the thirty-first of December. On the other hand, when, twelve hours later, the sun is on Greenwich meridian, the date will be the first of January for all the world, but will be afternoon for Asia and Europe and forenoon for America. At present the change of count, as above observed, is supposed to begin in the Pacific Ocean, But if we are to be exact, it ought to begin at some certainly defined meridian; and the present proposition is to make it begin at the meridian distant twelve hours from Greenwich.

The time determined by the proposed zero meridian is, according to a suggestion of Mr. Fleming adopted in the resolution, to be distinguished as cosmopolitan time, and might equally be called universal or absolute time. Any observation made in cosmopolitan time will be fixed with absolute certainty both in the chronological sequence and in the hours of the day, and it can easily be converted, by the addition or subtraction of an even number of hours, into the particular time of each standard meridian. Mr. Fleming proposes, also, that the hours of this universal time shall be distinguished by symbols or letters rather than by numbers. The value of this suggestion consists in the fact that by means of it the danger will be averted of ever confounding cosmopolitan time with that of any other except the prime meridian."[14]

Delegates from the American Metrological Society and from the Canadian Institute, were sent to the International Geographical Congress held at Venice in September, 1881. These delegates laid before that Congress the above proposed International time-system. Group 1, to which the resolutions were referred, reported as follows: "The Group 1 considers and emits the vote that within a year an International Commission should be appointed by the Governments to consider the question of an Initial Meridian, having in view not only the question of longitude, but especially that of hours and dates. The Commission should be composed of scientific men such as geodesists, geographers, and men who represent the interests of commerce, etc. Three mem-

bers should be named by each nation. The President of the Italian Geographical Society is requested to take the initiative in bringing the subject before his Government and foreign geographical societies, and to take the necessary steps for the realization of the request contained in the resolutions. The Group desires to draw attention to the proposition of the American delegates that the proposed International Commission should meet at Washington on or before May 1, 1883."[1]

From what has been shown, it appears that the proposed system is being widely discussed, and is generally favorably received. Efforts have been made to bring the whole subject before the railroad men of the country. Communications were presented at the General Time Convention of all the roads in the United States, held in New York City in October, 1881, from Professor Abbe, chairman of the committee on Standard Time of the American Metrological Society, and from Professor Ormond Stone, chairman of the committee appointed by the American Association for the Advancement of Science. These communications were referred to the secretary, with directions to report at the meeting to be held in Cleveland, in April, 1882. Public opinion is being informed in regard to the proposed system. In the near future we may hope to see the adoption of the suggested standards.

Prof. D. S. MARTIN read by title the following paper, to appear in full in the forthcoming Annals of the Academy, Vol. II, Nos. 7 and 8:

DESCRIPTIONS OF NEW SPECIES OF FOSSILS FROM OHIO, WITH NOTES UPON SOME OF THE FORMATIONS IN WHICH THEY OCCUR. By Prof. R. P. WHITFIELD.

He also presented the full programme of the Academy's Lecture-course for the season, in behalf of the Committee on Lectures. The course comprises the following subjects:

January 23.—THE MORAL BEARING OF RECENT PHYSICAL THEORIES. Prof. BENJAMIN N. MARTIN.

February 20.—ANCIENT CIVILIZATIONS IN AMERICA. Prof. JOHN S. NEWBERRY.

March 20.—SOME RESULTS OF PHOTOGRAPHY AS APPLIED TO ASTRONOMY. Prof. JOHN K. REES.

April 17.—THE SUBMARINE TUNNEL BETWEEN ENGLAND AND FRANCE. Count ERNST VON HESSE-WARTEGG.

May 15.—GLACIERS. Prof. H. CARRINGTON BOLTON.

NOTES FOR "THE INTERNATIONAL TIME SYSTEM."

[1] See Proceedings of the American Metrological Society, p. 18, Vol. II., Part I. Report of Committee on Standard Time, and Vol. II., Part II., page 175.

[2] A full description of this unique system is given in the January number of the *Popular Science Monthly*, by Prof. E. Engler, of Washington University, St. Louis.

[3] See Reports of the Superintendent of the Naval Observatory, in the Washington Astronomical and Meteorological Observations.

January 23, 1882.

The President, Dr. NEWBERRY, in the Chair.

The first of the regular monthly lectures of the course for 1882 was held in the large hall. The number in the audience was not recorded.

The President opened the course with a few brief remarks, and gave place to the lecturer of the evening, PROF. BENJAMIN N. MARTIN, of the University of the City of New York, who addressed the Academy on the following theme:

THE MORAL BEARING OF RECENT PHYSICAL THEORIES.

(ABSTRACT.)

The speaker maintained that the argument for the Divine existence from the adaptations discernible in nature has, with the recent progress of scientific ideas, undergone a great and essential modification. He quoted Paley's statement that no change takes place in an animal form from generation to generation. We do not, by running back through an indefinite series of ages, make any approach to accounting for the intelligence displayed in its construction; though if there were some slight gain at each step, we might by an indefinite series of generations, approaching nearer and nearer, account thus for the whole result.

The scientific opinion of Paley's day affirmed the fixedness of species; and, so long as that view was maintained, Paley's argument was unassailable. But now, Darwin has questioned this idea, and scientific opinion, in affirming the progressive development of species, has stricken away the foundation on which the teleological argument had

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NOTES FOR "THE INTERNATIONAL TIME SYSTEM."—*Continued.*

[4] See Annual Reports of the Director of the Astronomical Observatory of Harvard College.

[5] Reports of the Director of the Allegheny Observatory for 1872, *et seq.*

[6] Annals of the Dudley Observatory, 1866, *et seq.*

[7] Annual Reports of Director of Cincinnati Observatory, 1868, *es seq.*

[8] Pamphlet on "The Regulation of Time," etc. By F. A. P. Barnard, President Columbia College, New York City.

[9] Copies of St. Louis *Globe-Democrat* and St. Louis *Republican*, for January 11, 1881.

[10] See Proceedings of Am. Metrolog. Soc., Vol. II., Part I, page 24.

[11] Proc. Am. Met. Soc., Part II., Vol. III., p. 179. Standard Time-Circular No. 1.

[12] Am. Metrol. Soc. and Canadian Institute.

[13] The Penn. R.R. prints the time between 12 o'clock noon and 12 o'clock midnight with heavy faced type, besides putting in the designations A.M. and P.M.
Some of the railroads in the West have printed time-cards with the hours numbered from one to twenty-four. J. K. R.

[14] From a Pamphlet on "The Regulation of Time; International Coinage; The Unification of Weights and Measures; Sea Signals." By F. A. P. Barnard, S. T. D.

[15] Part of unpublished Report of Committee appointed to attend the Third International Geographical Congress, held at Venice, September, 1881.

been so confidently based. *Now*, what? This requires a consideration of recent scientific principles and an account of their bearing on theism.

The great results of scientific inquiry in our day are two, expressed each by a single word, EVOLUTION and CORRELATION. The first of these, evolution, is that the arrangements of nature are due, not to immediate acts of Divine creation, but to a process of slow development (1) from small beginnings, (2) by gradual changes, (3) through long periods, and (4) by the operation of natural forces.

This truth is no recent discovery of Mr. Darwin, though formulated by him in one department, but is the general characteristic of modern science. It is displayed (1st) in the great nebular hypothesis. This is simply an account of the development, through the process just described in its four particulars, of the astronomical system. Our own solar system discloses this as the method of its origin; the cosmical system illustrates the same process, and the nebulæ beyond alike suggest it. In this view all astronomers are now substantially, though with some variations, agreed.

(2d) Next: Geology manifests still more striking evidences of the same process of development. We can trace our globe downward from the condition of a fiery mass, on which water could not exist, to the formation of seas; in these the deposit of rocks—Archæan, Silurian, Devonian and the rest—took place according to the present laws of deposition; and still the process goes on to the present time, and gives us the whole body of the rocks with their elevations and depressions. In all this, geologists agree in finding the slow and gradual operation of natural forces.

Organic life is now claimed as falling under the same law; and thus we have almost the whole body of Science committed to the development theory.

This theory has two effects: 1st. It reduces all operation of creative power to a minimum; the changes at each point are insignificant: 2nd. It removes this minimum to the remotest period of time. The creative power may have formed germs, in the beginning; but for all else, the work of nature's forces will sufficiently account.

The other great scientific idea is that of the correlation or convertibility, of the Forces.

Working in quite a different sphere, and with no relation to the progress already described, Science has given us another change of views of altogether an opposite tendency. Phenomena are no longer ascribed to "fluids," as the electric, or the caloric, fluid. They are now conceived as due to molecular motions in things around us. "Heat," says Tyndall, "is a mode of motion;" and as clearer conceptions began to dawn

upon the scientific mind, it was found that several of these groups of phenomena, which had originally constituted distinct sciences, are at bottom only varying modes of motion, occasioned by the varying conditions of action, of a single force. Magnetism, and Voltaism were found to be but variations of electricity: soon electricity began to identify itself with chemical affinity: heat and light were correlated with each other; heat, moreover, showed its relation to electricity in the phenomena of thermo-electricity. At length Faraday, with the aid of Whewell, entered upon an elaborate investigation, and showed satisfactorily that all these phenomena are due to one general and all-pervading force. All are mutually convertible: and hence we have the theory of the unification of nature, in the doctrine variously described as the Persistence of Force, and the Correlation or Convertibility of the Forces. All specific forces are simply phases of one. This one is without beginning or end, it pervades the universe; it has framed the systems of the heavens and the earth. As expounded by Herbert Spencer, it is "coördinate with all orders of phenomena;" and is the real and sole author of all the changes which take place around us—the ever present, ever active, unbeginning, and unending nature-force which carries on the working of the universe.

It results from this, that there is no real force but this of the infinite, and that every other and more specific force is but a transient phase of the acting of the First Cause.

This conception of an infinite and diffused force or power, carrying on, as it has originated, the system of nature, is the very opposite in tendency of the former. Correlation is the counterpart of Evolution. While the latter removes the creative action to the farthest limit of time, the latter brings it into the present operations of nature. While evolution reduces the divine action to a minimum, correlation makes it the only active and vital thing in nature; while evolution attributes everything to physical forces in all the bodies of the world, correlation abolishes the very existence of these forces as distinct realities, and makes the infinite the only real agency—the ever active cause of all nature's changes. We are, therefore, brought—by this doctrine of correlation—face to face with the infinite and the eternal.

It is the most elementary doctrine of physics that every action involves an equal reaction. When, then, you act, what force is it that reacts against you? Whatever may be its humble name, or its familiar aspect, it is simply the force of the infinite.

To some, this may seem to involve the danger of Pantheism; but we are shut up to it, whatever the danger. It only brings us back, however, to the familiar conception of Newton, that "the laws of Nature are the established methods of the Divine action;" and Newton

was no Pantheist. The doctrine of "the convertibility of the forces," or, as others have preferred to state it, "the persistence of force," gives us a single infinite force as the life of the world; and this necessarily identifies itself with what the Christian calls God.

Spencer, indeed, maintains that we cannot know the infinite; but he himself calls it "the First Cause;" declares it is the vital agency in every change, and proclaims it "productive," and shows thus a clear knowledge of it in the weightiest possible relations.

Tyndall hesitates to speak thus plainly, and says: "I will not call him, or it, a cause or a power;" but silence is not philosophy. If there is this single and universal agency, the consequence follows that all nature's movement is due to this one great cause, which originally shaped the earth and formed the heavens.

Correlation lays the foundation for a belief in the theistic conception. We have but to prove the intelligence, and the moral and personal character of this infinite cause, and we have before us what Christ called the "Lord of heaven and earth;" and this, the familiar argument of Paley, and the rest of our teleological writers, enables us to do triumphantly.

In view of this great generalization, of one only force in the universe, the whole perplexing and obscuring maze of second causes and minor forces disappears—we are face to face with the infinite, with which alone we have to do. Thus, while Evolution seems almost to banish God from the creation, the profounder philosophy of Correlation restores this grand conception, and makes us feel that in very truth it is in the First Cause that "we live, and move, and have our being."

January 30th, 1882.

Section of Geology and Mineralogy.

The President, Dr. Newberry, in the chair.

Fifty-seven persons present.

The committee, consisting of the President and Recording Secretary, to whom had been referred the preparation of a memorial to the authorities of the State, regarding the completion of the volumes of the Geological Survey, reported the following resolutions, which were unanimously adopted by the Academy.

Whereas, A large amount of new and valuable material has been prepared by Prof. James Hall for the completion of his series of reports on the Palæontology of New York, many of the plates having been already engraved; and,

Whereas, The publication of this material would require only a rela-

tively small appropriation, and would give to the public the fruit of large expenditures previously made,—is demanded by the honor of the State,—and would greatly facilitate the labors of every geologist in the country;—

It is therefore,

Resolved, That the best interests of the State of New York, and the credit and usefulness of science in America, would be advanced by the completion of the great work on the Palæontology of New York, continued through so many years under the supervision of Prof. James Hall; and,

Resolved, That the members of the State Legislature be, and hereby are, earnestly requested to make the necessary appropriations for the publication of the material already prepared, while it may have the benefit of the supervision of the distinguished palæontologist who has been the author of the preceding volumes; and,

Resolved, That a copy of these resolutions, signed by the President and Secretary of the Academy, be transmitted to the Governor of the State, and to the presiding officers of the Senate and Assembly.

O. P. HUBBARD. J. S. NEWBERRY.
Rec. Secretary. *President.*

THE PRESIDENT read a letter from MR. CHARLES W. LOVETT, of Centre Marshfield, Mass., regarding the rate of accumulation of salt-marsh deposits in eastern Massachusetts. At various points in his vicinity, MR. LOVETT reports the finding of bricks identical with those used for the chimney of the old Peregrine White house, buried beneath three feet of compact undisturbed marsh-soil. Wood cut by the civilized axe, and other articles, he also mentions as found at the same depth, and in like situations. The rate of growth seems to be general, and not local or accidental; and some clue may thus be gained as to the movement of the coast-level in this region.

DR. ALBERT R. LEEDS gave a brief account of the methods of formation and the properties of a number of new componnds of the organic aromatic bases, with the haloid and other salts of the metals. The resulting compounds are substances formed on the ammonium type, with as many hydrogen atoms replaced as would correspond with the valences of the metallic radical entering into combination. When certain of these compounds, such as the Di-phenyl-mercurammonium chloride, or cyanide, or the Di-tolyl-mercurammonium cyanide, are exposed, along with carbon bisulphide, to the action of sun-light or of heat, part of the sulphur in the carbon bisulphide unites with the metallic radical, hydrochloric or hydrocyanic acid is evolved, and Di-phenyl-sulpho-carbamide or Di-tolyl-sulpho-carbamide is formed.

MR. WM. EARL HIDDEN then read the following paper:

THE DISCOVERY OF EMERALDS IN NORTH CAROLINA.

Mr. President, Ladies and Gentlemen:

That emeralds have been found in the United States, has been doubted. The press has stated "the discovery of emeralds needed confirmation." It is my pleasure to show you this evening convincing proof of the existence in our country of this rare and beautiful gem. Since what the impetus was that started the search for emeralds in North Carolina would be of interest, I will give you the story, gathered as it is from a year's residence on the spot where the discovery was made.

Sixteen years ago, the site of the North Carolina emerald mine was covered with a dense primitive forest. Less than ten years ago the locality was mineralogically a blank, nothing was known to exist having any special interest or value. Whatever we know of it to-day, is due indirectly to MR. J. A. STEPHENSON, a native of the country, whose interest in mineralogy is a purely natural one.

Under a promise of reward, if successful, he had engaged the farmers to search the soil for crystals, Indian stone relics, etc., and for some years enjoyed surprising success in thus gathering specimens.

Every specimen found in this region proves to be a revelation to science. In some respects they were of more interest than anything heretofore found of their kind.

Certain it is that this region, and I state this from my own experience in collecting, has produced some of the most remarkable and beautiful specimens of Emerald, Spodumene, Beryl, Rutile and Monazite, thus far discovered in the United States.

To be brief and to the point, I will say, that in a few localities in Alexander county, crystals would be brought of the common opaque beryl; but now and then a semi-transparent prism, having a decided grass-green color, much resembling the famous crystals from Siberia, so familiar to mineralogists, would be found and offered for sale in the neighboring towns. Those came to have the name among the farmers of "green rocks" and "green bolts." From the fact of their selling for more than anything else they found, these green crystals became the ultimatum of their searching.

Among other curious local names for minerals were "Donicks" for quartz crystals, "Black Bolts" for prisms of tourmaline, "Red Metal" for rutile crystals, and "Needle Rock" for the beautiful sagenite, or Arrows-of-love stone.

Suffice it to say that in a period of about six years, there were found loose in the surface soil, on three plantations in this county, a small

number of beryls having a color verging distinctly upon the true emerald tint, none of which crystals, however, were deep-colored or transparent enough for use as gems.

Some of these crystals were obtained by the Mr. Stephenson before mentioned. It was the sight of two of these "green bolts" which prompted me to visit the locality and make a search for the true emerald. I cannot understand why work was not commenced long ago, when such favorable signs were so common.

That such indications could receive only passing notice from collectors, is really inexplicable. A very natural conclusion would have been that where these pale emeralds were found loose in the soil, darker and purer ones would be found by mining for them.

Such inducements as the following were held out to the farmers to search for these "green bolts." A visiting collector had offered the munificent sum of *one dollar*, to farmers who should find a crystal as long as his finger, which must, to merit the dollar, be *dark green*, pure, transparent, and with perfect terminal planes and prismatic faces!

Such is the history of the emeralds found in Alexander county, before I commenced systematic mining for them.

The location of the mine was obtained in the following manner. A corps of workmen was employed to dig a series of deep ditches in directions that would cut the strata at different angles. The site chosen for work was on the spot where at least half a dozen pale emeralds had been found. This location was shown to me by the farmer who had discovered the specimens while plowing.

Not knowing then their manner of occurrence, I expected in this way to strike a vein bearing them. Five weeks were spent (in July and August, 1880) before any success was met with; and then, at a depth of eight feet was discovered a "blind vein" (so called because it had no outcrop), having very small emeralds. In this vein, or pocket, as it proved to be later, and outnumbering the emeralds fifty to one, was also found the new emerald-green mineral which was such a surprise to the scientific world, and which was destined to answer the same purposes as did the gem I sought. I refer to the spodumene-emerald, now known as Hiddenite.

You must pardon this digression, but the search for emeralds is so interwoven with my discovery of emerald-green spodumene that I cannot tell the story of one without the other. The two minerals occur intimately associated, and while mining for the one the other is constantly found.

This blind vein yielded very handsomely of the new mineral, but very sparingly of emeralds, and the few found were too small to be useful as gems, though their color was very good. A tunnel, for

the purpose of drainage, 261 feet long, mostly through rock, was cut to this vein, and a shaft sunk down upon it. At this time the work on this vein has reached a depth of 36 feet, at which point it proved its pocket nature by pinching out—closing together.

Thus far, twelve of these pockets have been found within an area of forty feet square, carrying emeralds, four of which pockets contained also the spodumene-emerald.

All these veins maintained nearly the same character of dip, thickness, length and associations.

Other pockets were found that yielded Quartz, Rutile, Monazite, and Mica crystals of great beauty. Others yet, whose walls were covered with finely crystallized Dolomite, Calcite, Apatite (transparent and pellucid) Rutile, Pyrite, Quartz and Mica.

In one instance, a small pocket that contained two beautiful emerald crystals, had its walls covered with large crystals of Albite (twinned parallel to the basal plane). Another pocket contained only Mica crystals and one small pellucid colorless beryl that had both ends brilliantly terminated with many planes. I mention the above associations, that you may learn the diversity in these pockets, although they are so near together.

In the rock-mining, and while prospecting on the surface, the sign of a vein is the presence of small streaks of massive quartz, or of mica, in a counter direction to the strike of the country-rock, either of which lead to open pockets not many feet off. The gems have thus far been found loosely attached to the rock. Not over nine emeralds have been found at any one time. Mineralogists have a great treat in store for them, when deep rock-mining is accomplished here. Then the gems will be found firmly attached, and they will shine with all their primitive crystalline beauty.

The largest emerald found in this mine is 8½ inches long, and weighs nearly 9 ounces. It was one of nine fine crystals contained in a single pocket; their color was excellent, and they were transparent, though somewhat flawed.

The locality is situated about 35 miles, air-line measure, S. E. from the "Blue Ridge" mountains. The contour of the country is low rolling, and its altitude is about 1200 feet. The soils are chiefly red gravelly clays, of not much fertility. The prevailing rock is gneiss, with more of a feldspathic than a micaceous character: the trend of the strata is N. N. W. and S. S. E. with a dip nearly vertical.

The gems and crystals occur in open pockets (miniature caves), of very limited extent, these are cross fractures or fissures in the rock. These fissures, lenticular in shape, are usually nearly perpendicular.

There being no glacial drift here, the soils are necessarily the result

of decomposition and disintegration on the spot. It is therefore an easy task to find the source of minerals found on the surface. The "*frost drift*" theory of Prof. Kerr is everywhere proven in this region. He well says that "to a foreign geologist, entering the South Atlantic States for the first time, a hundred miles or more from the coast, the most striking and novel feature of the geology is the great depth of earth that everywhere *mantles and conceals the rocks.* This is readily discovered to be, for the most part, merely the result of the decomposition *in situ* of the exposed edges of the underlying strata. The vertical and highly inclined bedding-lines of strata, *are distinctly traceable by the eye, through this superficial earth covering, and are seen to pass by insensible gradations into the undecayed rock beneath.*" At this locality, the unaltered rock is found at a depth of twenty-six feet, and is of unusual hardness, especially where it walls the gem-bearing pockets.

Thus far the gems have been found in a narrow belt running N. E. and S. W., and scattered over a distance of three miles. In this belt, signs of cross-fissures are very abundant, and it is a very common thing to find crystals of quartz, rutile, tourmaline, etc., etc., *perfectly preserved,* scattered over the surface.

A peculiar feature pertains to most of the emeralds and beryls from this region. They appear as though filed across the prismatic faces. The basal plane is also often pitted with minute depressed hexagonal pyramids, that lie with their edges parallel to one another, and to the edge of the di-hexagonal prism. Rarely, though, crystals are found with perfectly smooth and brilliant faces. The emerald color is often focused on the surface, and fades gradually to a colorless central core, which feature is of exceeding interest when the genesis of the mineral is considered. The emeralds have been found of richer color, and less flawed, as the mine gets deeper. [These points were illustrated by a beautiful series of specimens.]

In regard to the commercial value of the emeralds thus far found, I will frankly state that the majority of the crystals have little value for gem purposes; but as cabinet specimens they are unprecedented, and as such have a market value ranging from $25 to $1,000 each.

From the largest crystals, stones of over one carat weight could be cut, that would be marketable as gems; but as scientific specimens, the crystals in their entirety would have greater value. Certainly no better signs could be wished for than these specimens, to prove the existence at this locality of dark-colored crystals, pure enough for cutting into valuable gems.

This region has a great future as a gem-producing district. Mining skill and capital are the only essentials needed to insure success. It may be interesting to note that the entire expense of the work at this

locality has been more than repaid by the sales of the gems (Hiddenites) discovered. But for the liberal financial aid given to the writer by both Mr. RICHARD H. ROBERTS, of Albany, and Mr. JAMES D. YERRINGTON, of Cresskill, N. J., the work of discovery and development at this locality would have been very much retarded, if not indefinitely postponed.

DISCUSSION.

Dr. NEWBERRY remarked on the extreme beauty of the specimens exhibited by MR. HIDDEN, and the great interest of these discoveries, in which he had achieved such signal success, both practical and scientific.

Dr. R. P. STEVENS made some further remarks on the communication, comparing the aspect of the specimens, and the mode of their occurrence, with those of the emeralds from the celebrated locality near Bogota. He referred to the fact, also, that the Bogota mines had been worked by the early aborigines, and were doubtless the source of the emeralds described with so much enthusiasm by the Spanish historians of the conquest of Peru.

Mr. GEORGE F. KUNZ exhibited a remarkable series of prehistoric knives, flakes, and cores, of Obsidian, from the vicinity of the city of Guatemala, Central America. They were obtained by the partial cutting away of a mound, during the making of a new road, about six miles from the city. The excavation revealed a sort of little cyst or chamber, walled and roofed with slabs of stone or baked clay, within which this large quantity of obsidian knives had been carefully and quite regularly laid away. There was scarcely anything else in the chamber, but the broken and worn edges of many of the implements would indicate that they had been much used; and the suggestion is strong that this may have been a sacrificial mound, and that these were the implements used in the rites of sacrifice, perhaps for a long period.